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TRANSMITTAL FORM

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Total Number of Pages in This Submission 16

Application Number	**10/536,571**
Filing Date	**November 2, 2005**
First Named Inventor	**Taro KISHIBE, et al.**
Art Unit	**2811**
Examiner Name	**To Be Assigned**
Attorney Docket No.	**AOY-3992US**

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
  - ☐ Fee Attached
- ☐ Amendment/Reply
  - ☐ After Final
  - ☐ Affidavits/Declaration(s)
- ☐ Extension of Time Request
- ☐ Express Abandonment Request
- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Response to Missing Parts/ Incomplete Application
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- ☐ Drawing(s)
- ☐ Licensing-related Papers
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- ☐ Status Letter
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  - ***Copy of Preliminary Amendment***
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Remarks:

SIGNATURE OF APPLICANT, ATTORNEY OR AGENT

Firm Name	**RatnerPrestia**		
Signature			
Printed Name	**Lawrence E. Ashery**		
Date	**March 1, 2006**	Reg. No.	**34,515**

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Signature	Fran Petrillo		
Typed or Printed Name	**Fran Petrillo**	Date	**March 1, 2006**

AOY-3992US PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Taro KISHIBE, et al.

Serial No.: 10/536,571 Group No.: 2811

Filed: November 2, 2005 Examiner: To Be Assigned

For: METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION OF SWITCHED RELUCTANCE MOTOR, AND METHOD AND APPARATUS FOR SENSORLESS CONTROL OF SWITCHED RELUCTANCE MOTOR (AS AMENDED)

OIPE IAP04 MAR 06 2006 PATENT & TRADEMARK OFFICE

Filing Receipt Corrections
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REQUEST FOR CORRECTED FILING RECEIPT

1. Attached is a copy of the official filing receipt received from the PTO in the above application for which issuance of a corrected filing receipt is respectfully requested.

2. There is an error with respect to the following data:

☒ Incorrectly entered
and/or
☐ omitted

Error in	*Correct data*
1. ☐ Applicant's name	1.
2. ☐ Applicants' address	2.
3. ☒ Title	3. **METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION OF SWITCHED RELUCTANCE MOTOR, AND METHOD AND APPARATUS FOR SENSORLESS CONTROL OF SWITCHED RELUCTANCE MOTOR (Preliminary Amendment filed 05/26/05)**
4. ☐ Filing Date	4.
5. ☐ Serial Number	5.
6. ☐ Foreign/PCT Application Reference	6.
7. ☐ Other:	7.

3. No fee is due.

Respectfully submitted,

RatnerPrestia
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Lawrence E. Ashery, Reg. No. 34,515

CERTIFICATE OF MAILING (37 CFR 1.8a)

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Date: <u>**March 1, 2006**</u>

Fran Petrillo
Fran Petrillo

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APPL NO.	FILING OR 371 (c) DATE	ART UNIT	FIL FEE REC'D	ATTY.DOCKET NO	DRAWINGS	TOT CLMS	IND CLMS
10/536,571	11/02/2005	2811	3090	AOY-3992US	21	12	11

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Applicant(s)

Taro Kishibe, Nishinomiya-shi, JAPAN;
Subrata Saha, Anjo-shi, JAPAN;
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Power of Attorney: The patent practitioners associated with Customer Number 52473.

Domestic Priority data as claimed by applicant

This application is a 371 of PCT/JP02/12412 11/28/2002

Foreign Applications

Projected Publication Date: 05/25/2006

Non-Publication Request: No

Early Publication Request: No

Title

of switched reluctance motor and method and apparatus

Method and apparatus for estimating rotor position ~~and for sensorless control of a~~ switched reluctance motor

COPY

OIPE IAP64 MAR 06 2006 PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appln. No:	To Be Assigned
Applicant:	T. Kishibe et al.
Filed:	Herewith
Title:	METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR SENSORLESS CONTROL OF A SWITCHED RELUCTANCE MOTOR
TC/A.U.:	
Examiner:	
Confirmation No.:	
Docket No.:	AOY-3992US

PRELIMINARY AMENDMENT

Mail Stop PCT
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Sir:

Prior to examination, please amend the above-identified application as follows:

☒ **Amendments to the Title** begin on page 2 of this paper.

☒ **Amendments to the Specification** begin on page 3 of this paper.

☒ **Amendments to the Claims** are reflected in the listing of claims which begins on page 4 of this paper.

☐ **Amendments to the Drawings** begin on page of this paper and include an attached replacement sheet(s).

☐ **Amendments to the Abstract** are on page of this paper. A clean version of the Abstract is on page of this paper.

☐ **Remarks/Arguments** begin on page of this paper.

☒ **Please enter the enclosed Article 34 Amendment.**

COPY

Amendments to the Title:

Please replace the title with the following:

~~METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION AND FOR SENSORLESS CONTROL OF A SWITCHED RELUCTANCE MOTOR~~

METHOD AND APPARATUS FOR ESTIMATING ROTOR POSITION OF SWITCHED RELUCTANCE MOTOR, AND METHOD AND APPARATUS FOR SENSORLESS CONTROL OF SWITCHED RELUCTANCE MOTOR

<u>Amendments to the Specification:</u>

Please add the following <u>new</u> paragraph after the title and before the paragraph starting on page 1, line 6:

THIS APPLICATION IS A U.S. NATIONAL PHASE APPLICATION OF PCT INTERNATIONAL APPLICATION PCT/JP2002/012412.

Amendments to the Claims: This listing of claims will replace all prior versions, and listings, of claims in the application

Listing of Claims:

1. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r, the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor; and

(d) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing at which the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r.

2. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;

(b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(d) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r, the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(e) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,

(a_1) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r, or

(a_2) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

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(a_3) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r; and

(b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{cal} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est}.

3. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r, the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{cal} which is set at the reference angle θ_r related to the flux-linkage λ_r;

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the turn-off delay and turn-on delay relating to the reference angle θ_r.

4. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a reference flux-linkage λ_r, the reference flux-linkage λ_r related to a reference angle θ_r which lies between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) when the calculated flux-linkage λ_{ph} becomes greater than the reference flux-linkage λ_r during the active conduction of a phase, performing once the following procedures including,

(a_1) determining estimated rotor position information θ_{cal} from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model, or

(a_2) determining estimated rotor position information θ_{cal} by adding a correction angle Φ to the reference angle θ_r related to the flux-linkage λ_r; and

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{cal} in the previous cycle is determined; and

(c) correcting a turn-on delay and a turn-off delay which are related to the reference angle θ_r based on the estimated rotor position information θ_{cal}; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

5. (Cancelled)

6. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;

(b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(c) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(d) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{rn} (n=1,..,k), each of the reference flux-linkages λ_{rn} (n=1,..,k) related to each of reference angles θ_{rn} (n=1,..,k) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(e) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a_1) determining estimated rotor position information θ_{caln} (n=1,..,k) which is set at the reference angle θ_{rn} related to the flux-linkages λ_{rn}, or

(a_2) determining estimated rotor position information θ_{caln} (n=1,..,k) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model or inductance model, or

(a_3) determining estimated rotor position information θ_{caln} (n=1,..,k) by adding a correction angle Φ to the reference angle θ_{rn} related to the flux-linkages λ_{rn}; and

(b) calculating an absolute rotor position θ_{abs} by adding the estimated rotor position information θ_{caln} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase based on the estimated rotor position θ_{est}.

7. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{r} (n=1,..,k), each of the reference flux-linkages λ_{r} (n=1,..,k) related to each of reference angles θ_{r} (n=1,..,k) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

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(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} (n=1,..,k) which is set at the reference angle θ_{rn} related to the flux-linkages λ_{rn};

(b) calculating and updating an incremental rotor angle $\Delta\theta_n$ (n=1,..,k) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined;

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk}, averaging the incremental rotor angles $\Delta\theta_n$ (n=1,..,k) to determine and update an incremental rotor angle $\Delta\theta$; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and turn-off delay and turn-on delay related to the reference angle θ_{rn} (n=1,..,k).

8. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{rn} (n=1,..,k), each of the reference flux-linkages λ_{rn} related to each of reference angles θ_{rn} (n=1,..,k) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} (n=1,..,k) from the flux-linkage λ_{ph} by using either one of a predetermined flux-linkage model and inductance model,

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined,

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk}, averaging the incremental rotor angles $\Delta\theta_n$ (n=1,..,k) to determine and update an incremental rotor angle $\Delta\theta$, and

(d) correcting a turn-on delay and turn-off delay which are related to the reference flux-linkages λ_{rn}, based on the estimated rotor position information θ_{caln}; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and the corrected turn-off and turn-on delays.

9. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating a flux-linkage λ_{ph} of an active phase from the sensed d.c.-link voltage V_{dc} and the sensed phase current I_{ph};

(c) comparing the calculated flux-linkage λ_{ph} with a plurality of reference flux-linkages λ_{rn} (n=1,..,k), each of the reference flux-linkage λ_{rn} (n=1,..,k) related to each of reference angles θ_{rn} (n=1,..,k) which lie between angles corresponding to aligned rotor position and non-aligned rotor position in the motor;

(d) each time the calculated flux-linkage λ_{ph} becomes greater than each of the reference flux-linkages λ_{rn} during the active conduction of a phase, performing once the following procedures including,

(a) determining estimated rotor position information θ_{caln} (n=1,..,k) by adding a correction angle Φ to the reference angle θ_{rn} related to the reference flux-linkages λ_{rn},

(b) calculating an incremental rotor angle $\Delta\theta_n$ (n=1,..,k) by using an elapsed time from the instant at which the estimated rotor position information θ_{caln} in the previous cycle is determined, and

(c) when the calculated flux-linkage λ_{ph} becomes greater than the maximum reference flux-linkage λ_{rk}, averaging the incremental rotor angles $\Delta\theta_n$ (n=1,..,k) to determine and update an incremental rotor angle $\Delta\theta$;

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are determined according to the reference angle θ_{rn}.

10. (Cancelled)

11. (Cancelled)

12. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;

(b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc}, the sensed phase current I_{ph}, and a value completely or approximately equal to the minimum value of a motor inductance;

(d) comparing the sensed phase current I_{ph} with the estimated current I_s; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on a timing when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value.

13. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) calculating an estimated rotor position θ_{est} by adding up an incremental rotor angle $\Delta\theta$ every predetermined control period;

(b) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(c) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc}, the sensed phase current I_{ph}, and a value completely or approximately equal to the minimum value of a motor inductance;

(d) comparing the sensed phase current I_{ph} with the estimated current I_s;

(e) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,

(a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance,

(b) calculating an absolute rotor position θ_{abs} by adding the rotor position θ_{app} to a stoke angle of the motor, and

(c) determining and updating the incremental rotor angle $\Delta\theta$ by processing an error between the absolute rotor position θ_{abs} and the estimated rotor position θ_{est} through either one of a proportional-integral control and a proportional control; and

(f) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the estimated rotor position θ_{est}.

14. (Previously Presented) A control method of a switched reluctance motor comprising:

(a) sensing a d.c.-link voltage V_{dc} and a phase current I_{ph};

(b) calculating an estimated current I_s from the sensed d.c.-link voltage V_{dc}, the sensed phase current I_{ph}, and a value completely or approximately equal to the minimum value of the motor inductance;

(c) comparing the sensed phase current I_{ph} with the estimated current I_s;

(d) when an error between the sensed phase current I_{ph} and the estimated current I_s becomes equal to or less than a predetermined value, performing once the following procedures including,

(a) determining a rotor position θ_{app} which is related to the estimated current I_s in advance;

(b) calculating and updating an incremental rotor angle $\Delta\theta$ by using an elapsed time from the instant at which the rotor position θ_{app} in the previous cycle is determined; and

(e) controlling a turn-off angle θ_{off} of each active phase and a turn-on angle θ_{on} of the next active phase, based on the incremental rotor angle $\Delta\theta$, and a turn-off delay and a turn-on delay which are related to the rotor position θ_{app}.

15. (Cancelled)

16. (Cancelled)

17. (Cancelled)

18. (Previously Presented) An apparatus which is controlled in the method according to any one of claims 1 to 4, 6 to 9, 12 to 14.

19. (Cancelled)

20. (Cancelled)

Respectfully submitted,

Lawrence E. Ashery, Reg. No. 34,515
Attorney for Applicants

LEA/dlm

Dated: May 26, 2005

The Commissioner for Patents is hereby authorized to charge payment to Deposit Account No. **18-0350** of any fees associated with this communication.

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Kathleen Libby

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